El objetivo del proyecto coordinado RASMAP es avanzar en el conocimiento de la tecnología que haga posible el desarrollo de una plataforma, que mediante la aplicación de las tecnologías de realidad aumentada y utilizando tecnologías de posicionamiento basado en visión sin marcadores, facilite el desarrollo de Asistentes Personales Móviles (Wearable Personal Assistant).

El desarrollo de esta plataforma implica abordar varios retos tecnológicos:
• Superar las limitaciones de prestaciones inherentes a los equipos móviles: velocidad de procesado, capacidad de memoria, capacidad de almacenamiento, prestaciones gráficas, …
• Obtener sistemas de posicionamiento que no requieran alterar o adaptar el entorno.
• Optimizar para la transmisión y reproducción de contenidos multimedia a través de redes inalámbricas y sobre dispositivos móviles

La calidad y utilidad de los resultados científico-tecnológicos obtenidos se validará mediante el desarrollo de 2 demostradores, uno en el ámbito del Patrimonio Histórico como guía para visitantes y otro en el ámbito de la ingeniería mecánica, como asisitente para la teleformación.

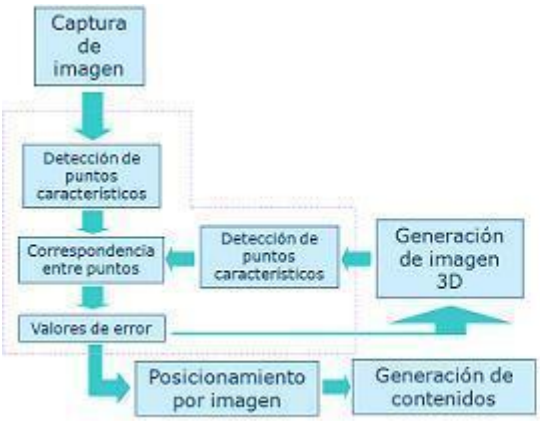
Actividad: en este proyecto se propone el análisis y desarrollo de un conjunto de metodologías de procesamiento-distribución de video y reconocimiento de imágenes en entornos móviles que sirva de soporte en el desarrollo de aplicaciones que conlleven transmisión multimedia para usuarios con movilidad. Entre las posibles aplicaciones de estas metodologías se encuentran futuros componentes y servicios dentro de las áreas de Realidad Aumentada y m-Learning.
La motivación del proyecto responde a una continuación natural de los trabajos realizados por el Grupo Multimedia-EHU y el Grupo de Tratamiento de Imágenes de la ESI (Escuela Superior de Ingeniería de Bilbao) en los proyectos de investigación realizados en los últimos años en virtud de los resultados obtenidos y la experiencia adquirida tanto en el área de transmisión de streaming multimedia a través de Internet, la adecuación de contenidos multimedia y creación de aplicaciones residentes en dispositivos móviles, como en el área de reconocimiento de imágenes.
Las metodologías a desarrollar se centran en los siguientes objetivos:
- Creación y distribución de contenido multimedia adaptada al entorno móvil: herramienta multimedia colaborativa, transmisión de vídeos 2D, e inclusión en la escena de realidad aumentada de animaciones 3D.
- Cliente móvil y Servicios distribuidos.
- Estudio y desarrollo de un sistema de reconocimiento de imágenes suministradas por una cámara móvil.
- Implementación de un sistema de comparación entre imágenes virtuales 3D e imágenes reales 2D.
- Integración sistemas m-Learning.

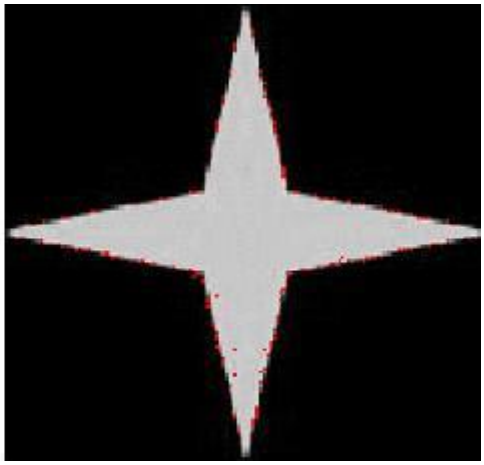
Resultados: en la primera parte del proyecto se han desarrollado a) un prototipo de creación y distribución de contenidos multimedia para entornos móviles, y b) la evaluación de métodos de detección de puntos característicos de una imagen.

a) Se ha desarrollado una plataforma de comunicaciones base para las aplicaciones multimedia y de realidad aumentada. La aplicación desarrollada, MobiMedia es una suite de herramientas integradas que permiten crear, editar y almacenar texto, imágenes, audio y video en el dispositivo móvil PDA basado en Windows mobile 5.0. La plataforma de comunicaciones permite a los usuarios compartir y colaborar sobre dichos contenidos multimedia a través de *web services* transparentes al usuario.

Los ámbitos de aplicación de MobiMEDIA pueden ser entre otros, la educación, el entretenimiento, visitas a museos y exposiciones, guia turístico, etc. Ver video de la apliación de MobiMEDIA en la impartición de Laboratorios Docentes (**video**).

b) La evaluación de métodos de detección de puntos característicos se ha realizado sobre imágenes reales y artificiales, para su aplicación en la detección de bordes, esquinas y contornos de los objetos.





* pertenece al proyecto coordinado por la Fundación LABEIN de título "RASMAP - Plataforma de Realidad Aumentada Sin Marcadores en Entornos Móviles para el Desarrollo de Asistentes Personales". Éste está compuesto por el presente proyecto PDVRIM y los proyectos "Plataforma Universal de Realidad Aumentada Móvil" (Fundación LABEIN) y "Sistema de Posicionamiento 3D sin marcadores basado en visión por computador" (CEIT).

Labraza (see figure 6). The user is equipped with the WPA. The WPA includes a data sheet to be completed during the inspection.

Figure 6: User in Labraza

The task focuses on the diagnosis of three different elements of historic centre selected: A residential building that is attached to the wall (number 1034), a building of historic interest (El Portal Sur) and a public space (La Plaza Alta).

4.2 Methodology

Examples of the sequence of actions to be taken during the inspection are detailed below:

- The user arrives to the first element to inspect.
- Turns on the WPA, identifies himself on the system, selects the element and the system shows on the screen its corresponding diagnosis procedure.
- The system provides instructions prior to diagnosis such as how to place the marker, informs that it must take a photograph of the facade and presents the sheet to be completed to establish the diagnosis.
- During the diagnosis, the system provides additional information for each of the sections in the sheet:
    - Accessibility: Based on the marker position, when the user asks for additional information to diagnose the accessibility of the building, 3D information relative to the accessibility normative in buildings will be shown.
    - Vaults: An interactive 3D model library of the most common types of vaults will be shown.
    - Facade preservation status: In this case it comes to detecting if the facade suffers any kind of pathology. For this purpose there are presented to the user a photo and a brief textual and oral description with the most common pathologies.
    - Covers: With the objective to detect the kind of cover of the building, visual information of the most common types of covers is presented to the user.
- During the diagnostic process the user can download multimedia information about other inspections carried out previously. This information includes photographs and audio files. The user can make notes on the photographs for review in subsequent inspections.
- The user may request the assistance of a remote expert by using the video conference system included in the application.
- When the user has completed the inspection of the building he will have to move to the next item to inspect. The system will provide information on the route to the next inspection element with a 3D arrow accompanied by a three-dimensional reconstruction of the historic centre indicating the most relevant environment elements to help the user in his orientation.

4.3 Application Development

For the diagnostic procedure, we defined three main diagnostic elements: a residential building attached to the wall, a building of historical interest and a public area. On the other hand, we defined two different types of user: an expert user, and a non-expert user. For each of the elements and for each type of user a diagnosis procedure is defined. Table I shows an example of the procedure of diagnosis. In particular, the one corresponding to a non-expert user who is in front of a building of monumental interest:

ACTION	DESCRIPTION	TYPE
Place marker	Instructions to place the marker on the building to inspect	Multimedia Information
Initial instructions	Initial instructions for the diagnosis	Multimedia Information
Accessibility	Information about accessibility	Augmented Reality
Vaults	3D model library of different kinds of vaults	3D Model Library
Covers	Information about kinds of covers	Multimedia Library
Pathologies	Information about the facade preservation status	Multimedia Library
Route to next	Information about the route to the next inspection point	Augmented Reality

Table I. Procedure actions

Concerning the contents, several types of information have been used in order to define the contents shown to the user. The main functionalities provided by the system are described below:

- *Multimedia information reproduction*: This is a reproduction of a single media file, which consists of a picture, text and audio.
- *Multimedia Library reproduction*: It corresponds with the reproduction of a multimedia file consisting of a sequence of photos, text and audio associated with each picture.
- *Augmented Reality visualization*: This functionality displays the image captured by the camera in real time, augmented with a virtual 3D scene in a position and orientation relative to the position of the detected marker. This type of content is mainly used for routing the user between the inspection points and for assistance in the accessibility diagnosis. Figure 7 shows how the WPA assists the user in the diagnosis of the accessibility in the building entrance.

Figure 7: Augmented reality for accessibility diagnosis

- *3D Models Library visualization and interaction*: This system allows the visualization of 3D interactive models. The interaction implemented allows rotation of the model, as well as zoom in and out of the camera.

- *Remote Expert Assistance*: The WPA includes a video-conference system which allows the user making the diagnosis contact with a remote expert for assistance during the inspection. Figure 8 shows the user and expert during the remote assistance of the diagnosis.

Figure 8: Remote expert assistance

- *Multimedia recording, downloading and annotation*: The WPA provides the user with the multimedia management system. A repository of multimedia content allows the user access to the recorded actions undertaken during previous diagnoses, and also the user can add new multimedia records as it is illustrated in figure 9.

Figure 9: Multimedia files annotation

4.4 Test

The prototype has not been validated yet, however we have performed a first test with one external user. In this section we provide some information about the test done. This test allows us to detect some advantages and disadvantages of the developed prototype.

In order to perform the test we moved to Labraza. There were three people involved in the test session: The responsible person of the WPA, the WPA developer, and the user, who is an architect with long experience in diagnostics conservation status of historic buildings and environments.

Prior to the start the session, the user is informed about the tool and the objectives of the session, informing that he will be observed and his actions and comments will be recorded with a video camera.

The main advantages detected by the user were:

- The manageability of devices exceeds expectations, as it can hang the PDA on the neck that gave freedom of hands movement to the user.
- The interaction with the application was simple and intuitive.
- Information provided was adequate and very interesting.
- The information presented using 3D models provided enough help and was of great interest for the user.
- The inclusion of the marker corresponding to the diagnosis element in the diagnosis sheet was very interesting and useful.
- Information given using 3D models with the aim of guiding the user in the environment was really useful.

The contents of augmented reality shown are very useful in the tasks of accessibility diagnosis and guidance to the next element. In the first case, the system allows the user to visually access the accessibility rules and make a diagnosis without measure. For guidance to the next point, visual information provided allows the user to orient easily within an unknown environment, as well as to reach the next inspection point in a simple way.

The tool for managing multimedia content provides apart from a mean of presentation of rich multimedia content that help during the diagnosis, other features like taking pictures, annotations over them, recovery of photographs taken during previous inspections, upload photographs for upcoming inspections and so on. These actions are also possible with other types of multimedia content such as video, text or audio.

Remote communication with an expert facilitates the diagnosis by non-expert users since the system allows accessing experts during the performance of the task.

However, problems were detected; for example:

- Light intensity on the screen of the PDA under conditions of high brightness outdoors is a bit poor.
- Battery life of the PDA during the assessment session was about 1 hour and 45 minutes, which is not enough to make the diagnosis of a complete historic centre.
- The user requests for the possibility to have the diagnosis sheet integrated in the WPA, which is not yet implemented.

5. CONCLUSIONS AND FUTURE WORK

In this paper we present the concept of Wearable Personal Assistant as an innovative tool for the assistance to professional and non-professional users in their daily activities. The concept of WPA has been defined in the context of a project called RASMAP in which we have developed a mobile augmented reality platform based on a service-oriented architecture.

Several software components have been developed for the implementation of the RASMAP platform. We have implemented an augmented reality rendering engine for mobile devices based on software and hardware implementations of OpenGL ES. Based on ARToolKitPlus, we implemented several algorithms to improve the robustness of such marker based tracking library using mobile devices. We have implemented also a multimedia management tool; this tool it is based on a set of web services and provides functionalities to record, edit, download and upload multimedia contents. In the RASMAP platform we have also integrated existing tools such as a video conferencing system for the remote communication between users remotely located.

The RASMAP platform is the technological support for the development of WPA. We have developed a prototype for the diagnosis of the built heritage. The tool has been tested on site by an architect with long experience in the diagnosis activities. Regarding the usability of the tool, although several problems